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[redacted]

the Hydraulically-Operated Automatic Clutch

DAIMLER-BENZ AKTIENGESELLSCHAFT

STUTTGART - UNTERTUERKHEIM

EXPORT SERVICE

MERCEDES-BENZ

Correction

The term HYDRAK used in this brochure should be replaced whenever necessary by the expression „Hydraulic-automatic Daimler-Benz clutch"

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Job No.
25 – 0

I. Introduction

The hydraulically-operated automatic clutch is designed to relieve the driver of the task of operating the clutch when starting-off and when changing gear, and to make this process automatic. Cars which are equipped with the hydraulically-operated automatic clutch have therefore no clutch pedal.

The hydraulically-operated clutch consists of four main assemblies:

a) The hydraulic start-off coupling
b) The conventional mechanical clutch
c) The servo assembly for operating the mechanical clutch
d) The control element which operates the servo assembly.

The vehicle is moved from a standing start by means of the hydraulic start-off coupling. The hydraulic coupling is so designed that the engine can idle with the gear lever engaged and its characterstistics also enable the vehicle to get off the mark very smoothly. The method of operation and characteristics of the hydraulic coupling are already known from the automatic transmission, but they are here repeated in detail in Section II, "Description of the Hydraulically-Operated Automatic Clutch".

The disconnection of engine and rear axle which is necessary when changing gear, is accomplished by means of a conventional mechanical clutch, with the difference that it is no longer operated via a clutch pedal but instead, is controlled by a servo assembly. The shift lever is the same in external appearance as hitherto and the gear positions are also unaltered. When the shift lever is touched, an electrical contact is made which operates the servo assembly via a control valve. This connects the vacuum side of the servo piston with the engine intake manifold while the high-pressure side is still subject to atmospheric pressure. The pressure differential furnishes the operative force necessary to throw out the mechanical clutch so promptly that the gearshift can be carried out in the normal way.

A free-wheel unit has also been incorporated in the hydraulically-operated clutch and this unit locks automatically whenever the car is overrunning the engine. Thus when the car is overrunning the engine, the engine and the rear axle are rigidly locked together. This arrangement enables the braking torque of the engine to be fully utilized right up to the moment when the vehicle comes to a halt, and at the same time, it enables the engine to be started quickly when the vehicle is being towed or pushed. Furthermore, it serves as a gradient lock, that is to say, when the car is placed in 1st gear on a downward slope or in reverse gear on an upward slope, it supplements the action of the hand brake to prevent the car rolling.

II. Description of Hydraulically-Operated Automatic Clutch

1. The Hydraulic Coupling

The simplest way of explaining the method of operation of a hydraulic coupling is to perform an experiment, using two ordinary electric fans. For this purpose, two electric fans are arranged facing each other (Fig. 25 – 0/1).

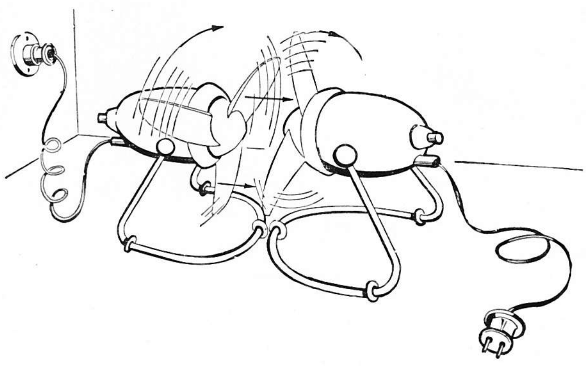


Fig. 25–0/1

When one of the fans is switched on, there is a stream of air which strikes the blades of the second fan and compels it to turn in the same direction of rotation. Power is thus being transferred from the first fan to the second and air is serving as the transfer medium.

A hydraulic coupling works on the same principle, but with the difference that

a) instead of air, a special oil is used as a transfer medium and
b) instead of the blades of the fan, turbine wheels are used.

The turbine wheels, the so-called members in the case of the hydraulic coupling, are arranged with the least possible clearance distance between them, in order to avoid losses (Fig. 25 – 0/2).

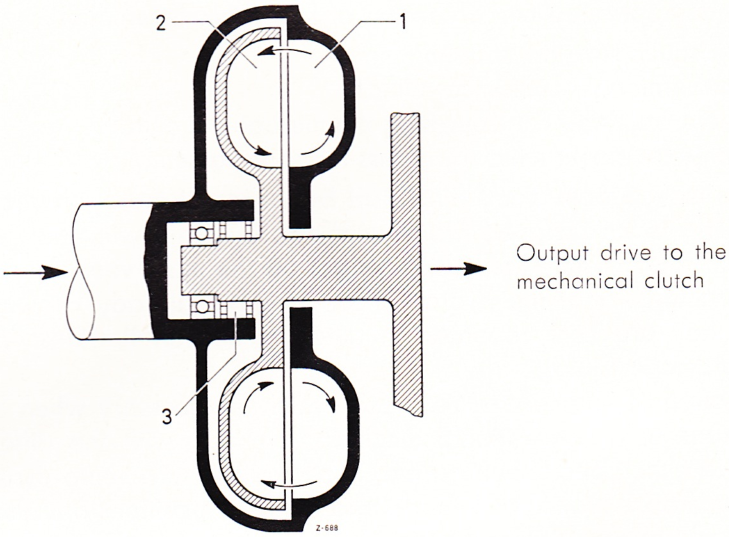
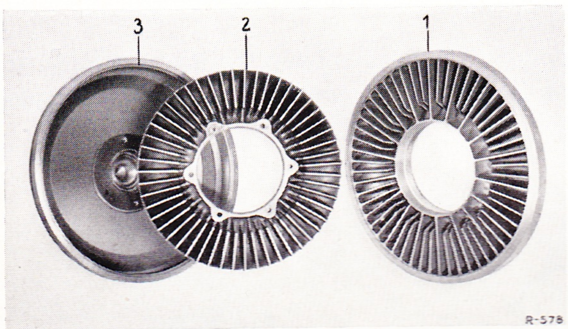


Fig. 25–0/2

1 Primary member
2 Secondary member
3 Free-wheel

The driving member (1), the so-called primary member, is welded to the clutch end plate. The driven member (2), the so-called secondary member, is mounted on a ball bearing.

The clutch end plate is bolted to the flywheel of the engine; this means that the primary member is permanently locked to the crankshaft of the engine. The secondary member, however, is connected via the mechanical clutch to the transmission and thus to the rear axle. The constructional form of the two members is shown in Fig. 25 – 0/3 in which the primary member (1), the secondary member (2) and the clutch end plate (3) are illustrated.



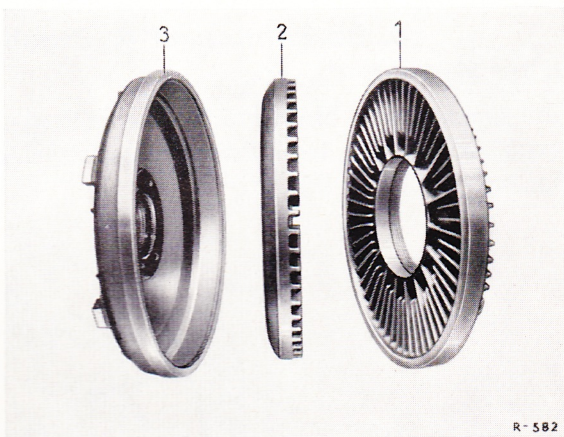


Fig. 25–0/3

1 Primary member
2 Secondary member
3 Clutch end plate

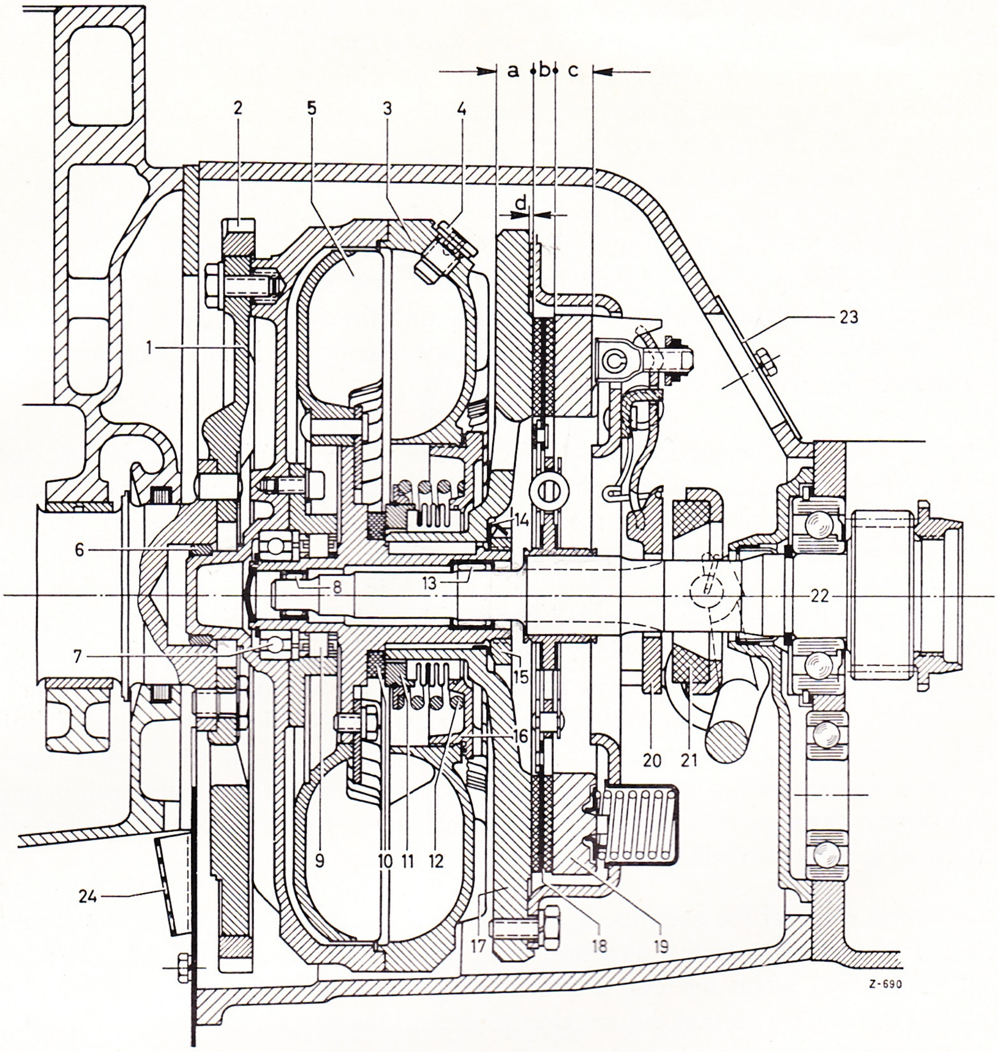
When the engine is started, the clutch end plate turns and this causes the primary member to turn at the speed of the engine. This rotary movement makes the oil in the hydraulic coupling turn in the same direction of rotation, due to the vanes of the primary member. This rotary movement causes the oil to be forced outward, due to the centrifugal force which is now operating, so that it leaves the vanes of the primary member at the outer part and strikes the vanes of the secondary member. The secondary member thus begins to turn in the same direction of rotation as the primary member. The oil is now directed from the outer part to the inner part of the secondary member where it emerges and is received by the inlet at the inner part of the primary member. There is thus a circulation of the oil between primary and secondary members (see arrows in Fig. 25–0/2). Power transmission between the primary and the secondary members is thus effected by the oil because the mass of the oil in the primary member is being accelerated and in the secondary member, it is being bracked.

The overall motion of the oil thus forms a kind of spiral which may be regarded as describing a circular path around the rotary axis of the hydraulic coupling since on the one hand the oil is being carried round in the direction of rotation of the engine and on the other hand, there is a circulation of oil between primary and secondary members.

The hydraulic coupling enables a stepless change of speed to take place, that is to say, the secondary member is at first stationary when the car starts off – with the gear engaged – and then it gradually starts to turn and increases its speed until it is revolving at almost the same speed as the primary member. There will, however, always be a slight difference in speed between the primary and the secondary members. This difference is referred to as slip and is approximately 2 %. Since the efficiency of the coupling is expressed in terms of the relationship between the speed of the output drive n_2 and that of the input drive n_1, it can be seen that the efficiency is approximately 98 % when travelling at even speed on the level.

Between the flange shaft of the secondary member and the clutch end plate, the free-wheel unit (3) is located. This unit locks in the direction opposite to the direction of rotation of the engine (see Fig. 25 – 0/2). Thus when the car is overrunning the engine, it causes the rear axle to be rigidly locked to the engine so that the braking torque of the engine can be fully utilized right up to the moment when the vehicle comes to a halt.

Sealing of the hydraulic coupling on the mechanical clutch side is done by means of a specially constructed axial seal. The graphite ring (10) is pressed hard against the sealing surface of the flange shaft of the secondary member by means of a thrust ring on which pressure is exerted by the spring (12) (Fig. 25 – 0/4). The seal between the thrust ring and the threaded ring which is screwed into the clutch end plate, takes the form of a metal bellows which connects the two parts and acts as a cushion.



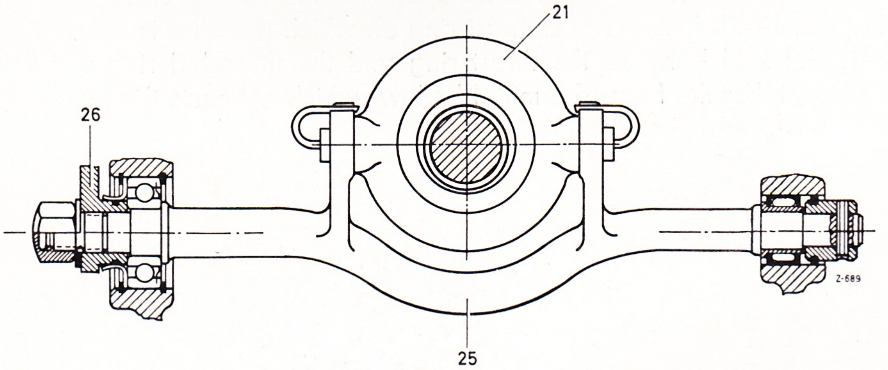


Fig. 25–0/4

a = 14.5 mm
b = 7.8 + 0.3 mm
c = 14.5 mm
d = 1.5 mm

1 Flywheel
2 Starter ring gear
3 Primary member
4 Screw plug
5 Secondary member
6 Centering ring
7 Annular grooved bearing
8 Needle bearing
9 Free-wheel unit
10 Graphite sealing ring
11 Thrust ring
12 Pressure spring
13 Needle bearing
14 Locking plate
15 Grooved nut
16 Threaded ring of axial seal
17 Drive plate
18 Driven plate
19 Contact plate of clutch pressure plate
20 Thrust collar
21 Throw-out bearing with graphite ring
22 Drive shaft
23 Cover plate for cooling-air inlet
24 Cover plate for cooling-air outlet
25 Throw-out shaft
26 Release lever

2. The Mechanical Clutch

The mechanical clutch consists of the drive plate (17), the driven plate (18) and the actual clutch with contact plate (19) (see Fig. 25 – 0/4). The drive plate (17) is bolted to the flange shaft of the secondary member with a grooved nut; a Woodruff key is installed between the flange shaft and the drive plate.

The drive shaft of the transmission is mounted on two needle bearings in the flange shaft of the secondary member. When the mechanical clutch is thrown in, therefore, the secondary member is rigidly locked to the drive shaft of the transmission.
Fig. 25 – 0/5 shows the way in which the hydraulic coupling and the mechanical clutch are put together.

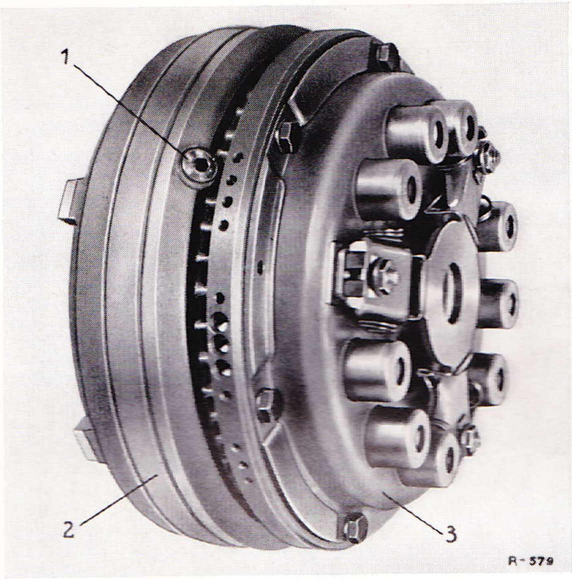


Fig. 25–0/5

1 Screw plug
2 Hydraulic coupling
3 Mechanical clutch

3. The Clutch Housing

The clutch housing is fastened in the normal way to the jointing plate or direct to the crankcase. The heat developed in the hydraulic coupling, particularly under load when considerable slip is present, is dissipated by means of cooling-air. For this reason, apertures for the inlet and outlet of the air have been made in the clutch housing and they are covered by perforated metal covers. The cooling-air enters through the cover plate (23) and the exhaust air emerges through the cover plate (24) and at a further perforated cover plate on the left at the bottom of the clutch housing (see Fig. 25 – 0/4).

4. The Servo Assembly and the Control Element

The mechanical clutch is operated via a connecting rod by means of a servo assembly (1) which is fixed to the left side of the crankcase (Fig. 25 – 0/6).

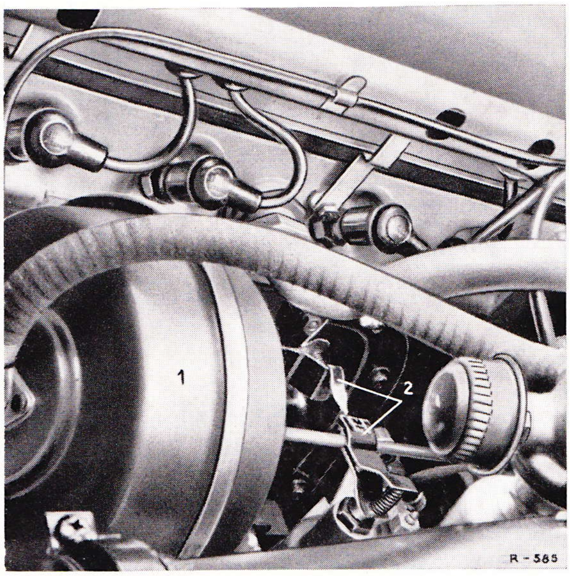


Fig. 25–0/6

1 Servo assembly
2 Adjusting Clamps for Clutch
180 589 12 23

The servo assembly is controlled by means of the control element (2) which is located at the left air scoop (see Fig. 25 – 0/20). The action of the control element is in turn modified by an electrical switch contact at the rear axle (see Fig. 25 – 0/18) via the relay (1) (see Fig. 25 – 0/20).

III. The Working of the Hydraulically-Operated Automatic Clutch

When the engine is running, and particularly when it is idling with the throttle valve (3) only slightly opened, a considerable vacuum prevails in the engine intake manifold. This vacuum is transmitted via the vacuum line (4), the check valve (17) and the vacuum line (5) to the supply reservoir (H) (Fig. 25 – 0/8).

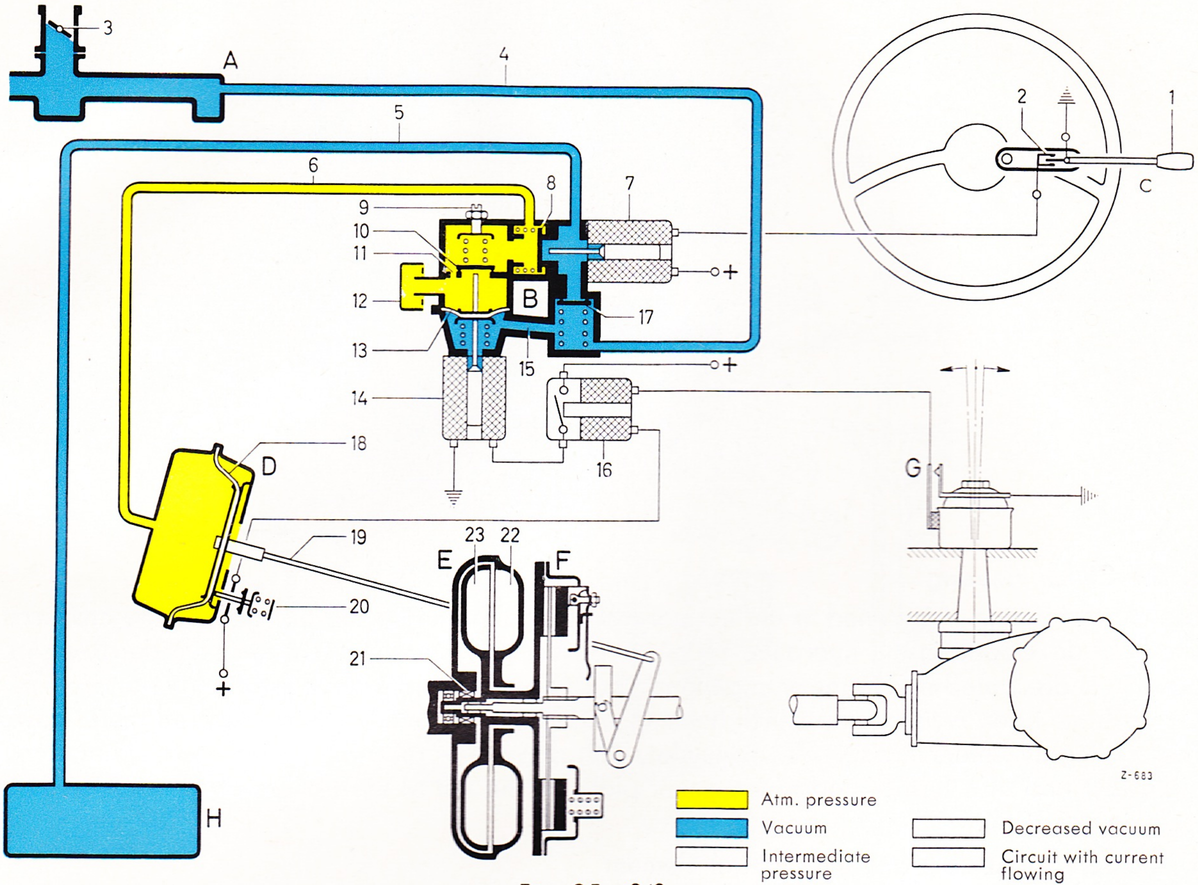


Fig. 25 – 0/8

A Intake manifold
B Control element
C Shift lever
D Servo assembly
E Hydraulic coupling
F Mechanical clutch
G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intakte manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly
7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal
16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

The check valve (17) prevents the vacuum in the supply reservoir (H) from being dissipated when the depression in the intake manifold is decreased when the throttle is opened or when the engine is stopped. The vacuum valve and the unions must be leak-proof so that the vacuum supply in the reservoir remains effective at least overnight.

The atmospheric pressure is able to reach the vacuum side of the servo assembly via the air cleaner (12), the jet (11) and the line (6) so that the pressure springs of the mechanical clutch press the contact plate onto the driven plate and thus onto the drive plate, that is to say, the mechanical clutch is thrown in.

As soon as the shift lever (1) is touched, the electrical contact (2) is closed and the electro-magnet (7) of the control element is energized. This causes the valve (8) to be thrust open so that the vacuum side of the servo assembly is connected to the intake manifold and / or the vacuum reservoir (Fig. 25 – 0/9).

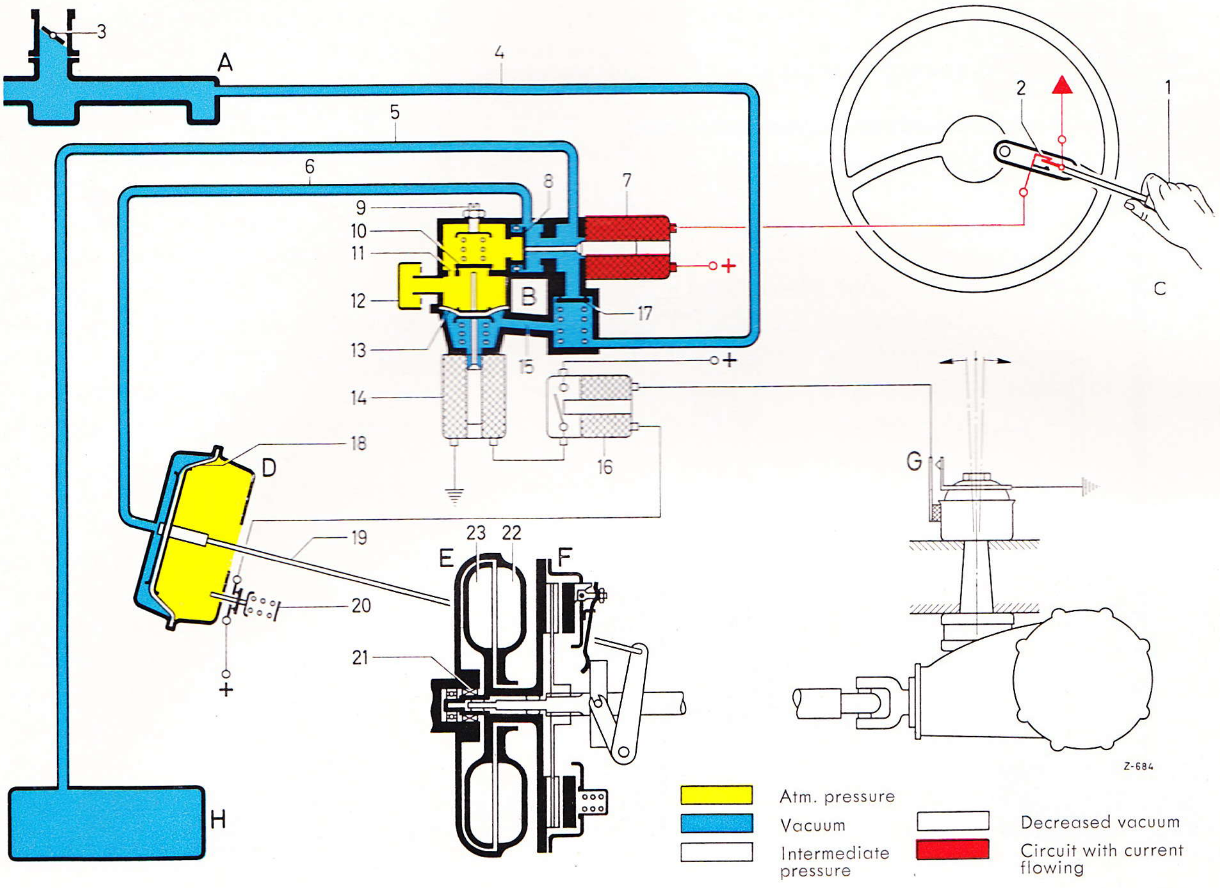


Fig. 25 – 0/9

A Intake manifold
B Control element
C Shift lever
D Servo assembly
E Hydraulic coupling
F Mechanical clutch
G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intakte manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly
7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
10 Reducing valve
11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal
16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

At the same time the valve (8) closes the canal to the reducing valve (10). The difference in pressure between the atmospheric pressure and the vacuum causes the diaphragm (18) of the servo assembly (D) to be drawn to the left and the mechanical clutch (F) is thrown out via the connecting rod (19). The mechanical clutch is thus released simply by touching the shift lever and the release is therefore effected before every gear shift. The process of throwing out the clutch is so rapid that a smart gear shift can be effected.

Engaging of the clutch after the gearshift operation commences immediately the shift lever is released. As soon as the driver's hand lets go of the shift lever, the current supply to the electro-magnet (7) is interrupted and thus the control valve (8) of the servo assembly (D) is cut off from the intake manifold of the engine and / or from the vacuum supply reservoir (Fig. 25 – 0/10). The canal to the reducing valve is once more opened up.

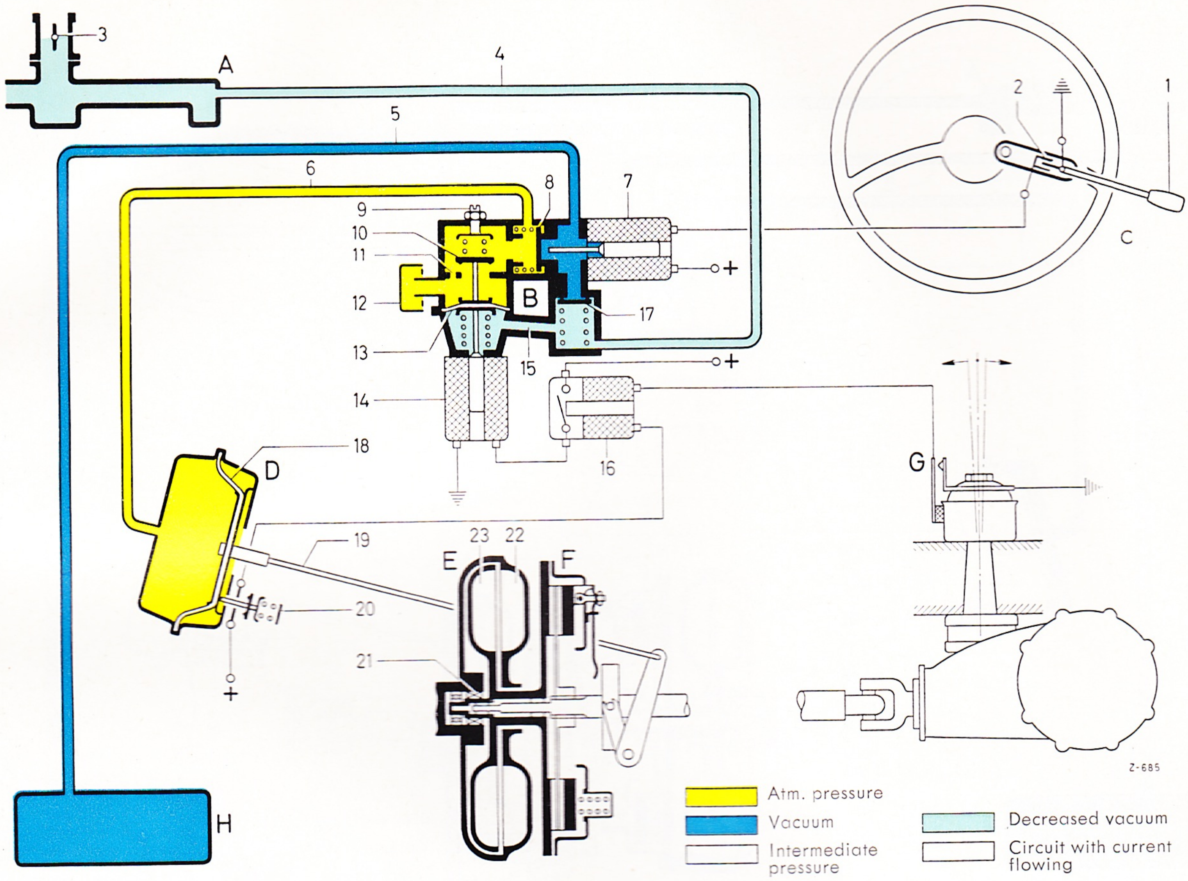


Fig. 25 – 0/10

A Intake manifold
B Control element
C Shift lever
D Servo assembly
E Hydraulic coupling
F Mechanical clutch
G Electrical switch contact at rear axle
H Vacuum supply reservoir

1 Shift lever
2 Electrical contact
3 Throttle valve in carburetor
4 Vacuum line from intakte manifold to control element
5 Vacuum line from control element to supply reservoir
6 Vacuum line from control element to servo assembly
7 Electro-magnet for control valve
8 Control valve
9 Adjusting screw for reducing valve
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11 Jet in reducing valve
12 Air cleaner
13 Spring-loaded diaphragm
14 Solenoid for spring-loaded diaphragm
15 Vacuum canal
16 Electrical relay for solenoid
17 Check valve
18 Roller bellows in servo assembly
19 Connecting rod
20 Limit switch
21 Free-wheel unit for hydraulic coupling
22 Primary member
23 Secondary member

The breakdown of the vacuum in the servo assembly and the simultaneous increase of torque transmitted by the mechanical clutch, takes place in two phases. In the first phase the vacuum is dispersed very quickly until the mechanical clutch begins to grip, because now the reducing valve (10) opens. With the closing of the control valve (8) the remaining vacuum in the servo assembly produces a suction effect on the reducing valve (10) so that the atmospheric pressure entering via the air cleaner (12) can force it open.

As soon as the vacuum has decreased to a certain value, the spring-loaded reducing valve closes once again. The second phase now begins. The dispersal of the vacuum takes place gradually by virtue of the small jet (11) so that the mechanical clutch engages slowly and smoothly. The timing